Zootaxa 1910: 21–26 (2008)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

The *Acer* seed midge, *Acumyia acericola,* an unusual new species and genus of Lasiopteridi (Diptera: Cecidomyiidae) with aciculate ovipositor and larval puparium

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Abstract

The *Acer* seed midge, a new species and genus of gall midge*, Acumyia acericola* (Diptera: Cecidomyiidae), is described on the basis of larval, pupal and adult specimens from collections made at Hainault Forest and Lambourne Common, Essex, and other parts of the UK, during 2006–08. The new genus is distinguished from all known genera of Cecidomyiidae by the combination of a larval puparium and an aciculate ovipositor. It is assigned to the supertribe Lasiopteridi and probably belongs in the tribe Dasineurini. Larvae develop in the ovular cavities of field maple, *Acer campestre* L., and Norway maple, *A. platanoides* L., and prevent seed development. Observations suggest that this species is biennial, with final instar larvae surviving for at least two years in *Acer* seeds lying in leaf litter and soil. The species has been recorded from *Acer* seeds in continental Europe and plant quarantine interceptions in the USA indicate that the same or similar species are present in Japan and China. Two puparia, possibly of this species, were discovered recently in *A. palmatum* fruits collected in Honshu, northern Japan.

Key words: Cecidomyiidae, Lasiopteridi, gall midge, *Acer,* UK, Japan, China

Introduction

In July 2006, larval puparia of an unusual cecidomyiid were found in fruits of field maple (*Acer campestre* L.) collected by Brian Ecott in Hainault Forest and Lambourne Common, Essex, UK. Within a few weeks I found similar puparia at other locations in the UK on *A. campestre* (fig. 1) and on Norway maple (*A. platanoides* L.). Earlier records of the same or similar species were then found from continental Europe (where the puparia had been misidentified as pupae of a phorid fly, *Megaselia giraudii* (Egger)) and from North America (where they had been intercepted at USA ports of entry in seeds of ornamental maples imported from Japan). A preliminary account of these observations was published (Harris 2006). At that time adults had not been reared so the generic placing could not be established. Puparia from the original and subsequent collections in 2006 were overwintered in an unheated outbuilding in Surrey, UK, but produced no adults in 2007. Final instar larvae within the puparia remained alive and active through the second winter of 2007-2008 and adults successfully emerged in May 2008. Morphological characters indicate that the species belongs in the supertribe Lasiopteridi, and probably in the tribe Dasineurini, but the combination of an aciculate ovipositor and larval puparium is not known in any genus of Lasiopteridi, or in any other genus of Cecidomyiidae. A new genus is therefore established for this species and information on its biology and geographical distribution is provided.

Accepted by S. Winterton: 23 Sept. 2008; published: 20 Oct. 2008

Material and methods

Puparia were obtained by dissecting samples of *Acer* fruits under a stereoscopic microscope. At first it was thought that the cecidomyiid larvae induced galling of the fruits but this was a result of the chance association of the initial Hainault Forest collection with distortions of the fruits, possibly caused by eriophyid mites (Harris 2006). Subsequent sampling of hundreds of *Acer* fruits from various locations has failed to detect any obvious external signs of the presence of larvae or puparia within the ovular chambers of the fruits. Adults were reared by placing numbers of live puparia together in 5 x 2 cm plastic tubes on a 3 cm layer of peat, sand and vermiculite, and the closed tubes were then stored in an unheated outbuilding, where larvae survived for more than two years. Samples of larvae, puparia, adults and pupal exuviae were preserved in 70% isopropanol. For examination by incident light and phase-contrast microscopy, and for photography, specimens were cleared and mounted temporarily in a concentrated solution of phenol in isopropanol. Micrographs were produced using Helicon Focus 4.21 image-stacking software to enhance depth of field. Type specimens were slide-mounted in Euparal and non-type material was mounted in Hoyer's medium. Terminology is based on McAlpine *et al.* (1981) and Gagné (1989). Types and associated specimens have been deposited in the Natural History Museum, London, UK.

Descriptive taxonomy

Acumyia Harris (new genus)

Figures 1–10.

Diagnosis. This new genus is distinguished from all other known genera of Cecidomyiidae by the following combination of characters: larval sternal spatula with single triangular (not bilobed) anterior blade (fig. 8); plus final instar encased in a distinctive brown, shiny puparium (fig. 7); plus female ovipositor needle-shaped (aciculate) and fully retractable into the abdomen (fig. 4) and pupa with exceptionally long cephalic setae and prothoracic spiracles (figs 9,10). The presence of parameres in the male genitalia indicates that the genus belongs in the supertribe Lasiopteridi and other characters (especially the male flagellomeres with long, narrow necks; wing with R5 joining C before the wing apex and longitudinally divided female abdominal tergite 8) suggest that it is morphologically close to *Dasineura* Rondani and associated genera. But it is difficult to place it with any certainty, especially as the higher classification of the Dasineurini is not well defined (Sylvén and Tastás-Duque 1993; Gagné 2004). Various types of piercing ovipositor occur in a few genera of Lasiopteridi (Gagné 1975) but aciculate ovipositors rarely occur in the supertribe, one known exception being in the genus *Actilasioptera* Gagné. A similar aciculate ovipositor is also characteristic of the widespread and speciose genus *Asphondylia* Loew, which belongs in the supertribe Cecidomyiidi, and is therefore not closely related to *Acumyia*. The occurrence of a larval puparium is similarly unusual. The only other genus of Lasiopteridi in which puparial development is known to occur is *Mayetiola* Kieffer, with the so-called 'flax-seed' puparia of the Hessian fly, *M. destructor* (Say), the best-known example. But the aciculate ovipositor of *Acumyia* is quite unlike the soft, telescopic ovipositor of *Mayetiola* and the male genitalia and female abdominal tergites of *Acumyia* suggest closer affinity with the Dasineurini. DNA sequencing may help clarify this tentative assessment. The genus *Acumyia* currently contains only the type species, *Acumyia acericola* Harris.

Etymology. The name is derived from Latin *acus* (needle), and Greek *myia* (fly), and relates to the needle-like aciculate ovipositor.

***Acumyia acericola* Harris (new species)**
Figures 1–10.

Adults. Wing length about 2–3 mm, with R5 vein joining costa before wing apex. Anterior edge of wings and distal half of legs with clothing of narrow, elongate black scales, easily lost in slide preparation. Antennae with 16–17 flagellomeres in females, all with very short necks, and 17–18 flagellomeres in males, all except last with distinct long narrow necks. Circumfila simple in both sexes, each flagellomere with distal and proximal thread-like rings connected by two longitudinal strands. Eyes holoptic, with circular ommatidia and median eye-bridge about 5 ommatidia long. Maxillary palps four-segmented. Head with 20–30 frontoclypeal setae and lateral thorax with 15–20 anepimeral setae. Tarsal claws roundly curved and sharp-pointed, empodium extending just beyond claws, pulvilli about half as long as claws and claws on all legs each with a strong basal recurved tooth about a third the size of the claw.

Female abdomen with sclerotized needle-like aciculate bulbous-based ovipositor 0.5–0.7 mm long, retracted into the abdomen (fig. 4). Tergites 1 to 6 rectangular, covered with small scales and each with a single row of fine hair-like setae posteriorly; tergite 7 quadrate and concave laterally, with an anterior pair of trichoid sensilla, a pair of small antero-lateral sclerotized excrescences, similar to setal points of insertion, but without setae, and a posterior row of fine setae; tergite 8 longer than other tergites and divided into two longitudinal separate strap-like sclerites, each with an anterior trichoid sensilla but without setae or scales.

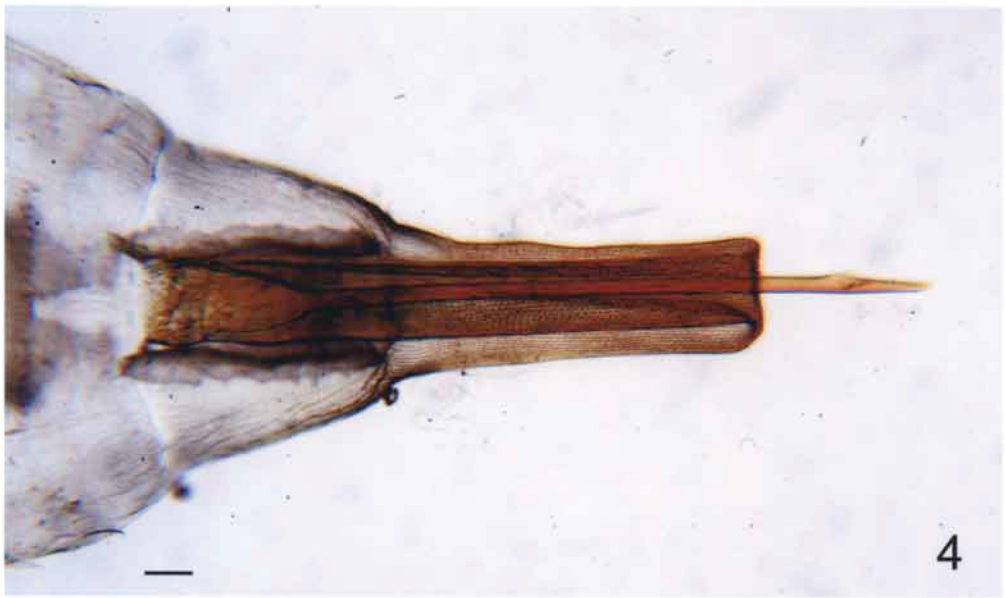
Male genitalia (figs 5, 6) with cerci deeply separated, hypoproct shorter than cerci and shallowly excavate distally, aedeagus narrowly tapered distally and tightly enclosed by strong, light-brown parameres which have distal fine hairing dorsally; haired dorsobasal lobes present at the base of the gonocoxites (fig. 6), which are elongate cylindrical; gonostyle narrow with uniform width, not tapered distally. Tergites 1–6 rectangular, clothed in small scales and each with posterior row of fine setae; tergites 7 and 8 reduced, 7 with a few lateral setae and 8 without setae; all tergites with a pair of anterior trichoid sensilla.

Larvae and puparia. Final instar larva white, about 3 mm long, and developing within a transparent, brown, sclerotized, slightly flattened puparium (fig. 7), formed from the skin of the penultimate instar, as indicated by the presence of the remains of the larval head capsule anteriorly. Sternal spatula of final instar with long shaft and pointed, triangular terminal blade (fig. 8); larval integument entirely shagreened, without obvious mamelons or transverse spinule rows ventrally; terminal papillae with very short setae. Most papillae difficult to distinguish from the shagreened integument but a full complement of dorsal, pleural, lateral, terminal, sternal and ventral papillae present, as illustrated for *Dasineura gleditchiae* (Osten Sacken) by Gagné (1989), mostly without setae or with very small, inconspicuous micro-setae.

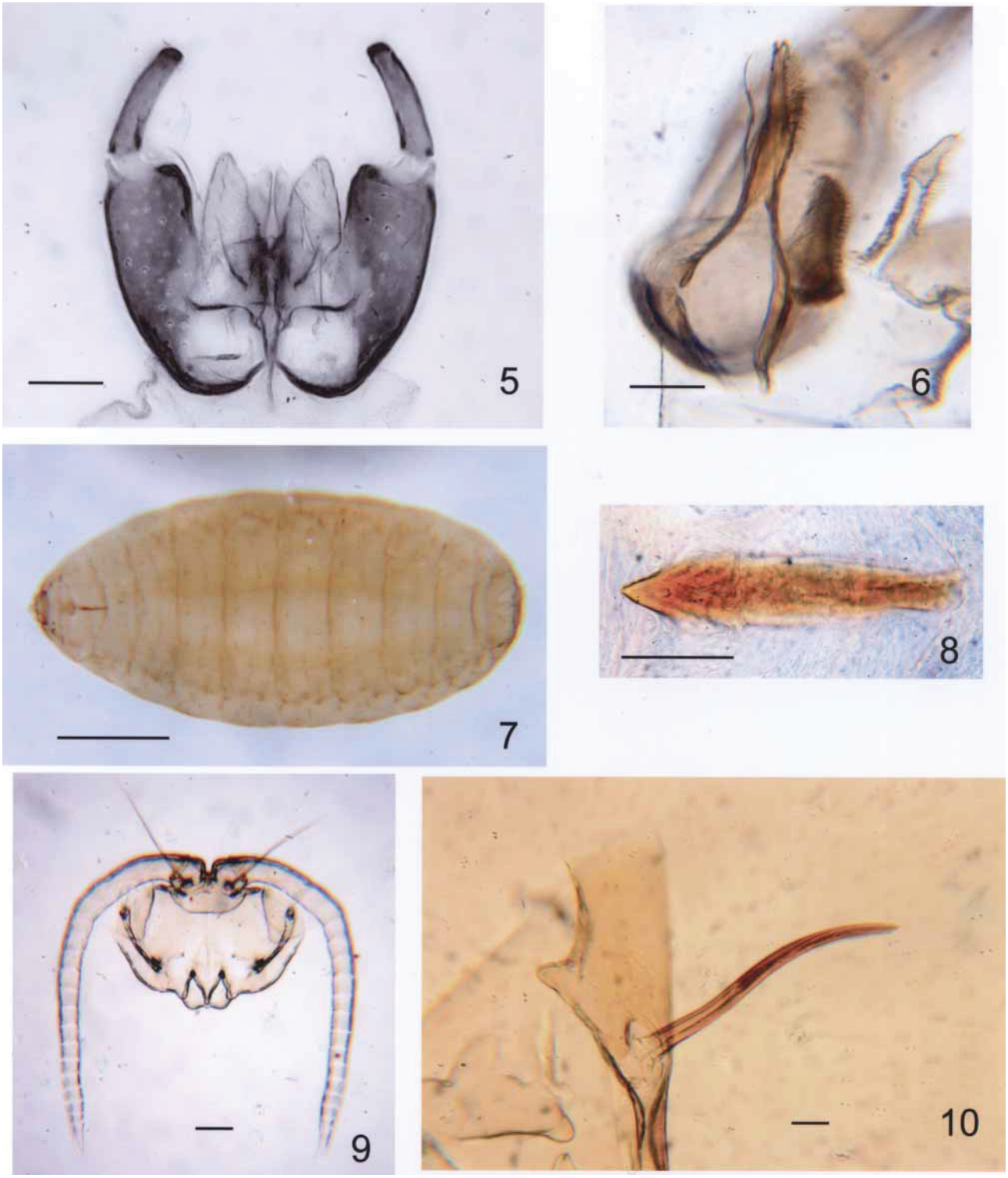
Pupae. Enclosed within the puparium. Lacking antennal and frontal horns but with long cephalic setae (fig. 9) and long, tapering prothoracic spiracles (fig. 10); abdominal tergites with tightly-packed fields of spines and spinules.

Material examined. HOLOTYPE male no. 20554, UK, Essex, Hainault Forest/Lambourne Common, ex fruits *Acer campestre* collected vii-viii.2006 (B. Ecott), emerged iv-v.2008 (K. M. Harris). Paratypes males nos. 20548, 20549, 20555, and females nos. 20542, 20545, 20547, 20550, 20556, 20557, same data as holotype, plus pupal exuviae on slide no. 20553 and additional specimens of adults, larvae, puparia, and pupae preserved in 70% isopropanol in a 45 x 20 mm screw-topped glass vial. All deposited in the Natural History Museum, London, UK.

The following additional material was also examined: puparia and larvae collected by K. M. Harris from *Acer campestre* fruits, at Sheepleas, East Horsley, Surrey, viii. 2006 and 28.vii.2008; at Holride Farm, Ripley, Surrey, 05.viii. 2006 and 25.vii.2008; at Westcott Down, Surrey, 16.viii.2006 at Queenswood Country Park, Herefordshire, 09.ix.2006 and at High Wood Country Park, Colchester, Essex, 07.ix.2008; and from *A. platanoides* fruits at Sheepleas, East Horsley, Surrey, 8.viii and 16.viii.2006.



FIGURES 1–4. *Acumyia acerivora* **gen. nov., sp. nov.** 1. *Acer campestre* fruit with ovular cavity exposed to show two puparia lying near the developing ovule. [Scale line = 5 mm.] 2. male and 3. female [Scale lines = 0.5 mm.]. 4. Micrograph of the aciculate ovipositor partly everted from the abdomen, showing the divided tergite 8 above the bulbous base of the ovipositor. [Scale line = 0.05 mm.]



FIGURES 5–10. *Acumyia acerivora* **gen. nov., sp. nov.** 5. Micrograph of male genitalia, dorsal view. [Scale line = 0.05 mm.] 6. Micrograph of the male genitalia, lateral view, focused on the brown parameres that enclose the aedeagus and also showing one of the dorsobasal lobes and the hypoproct. [Scale line = 0.05 mm.] 7. Puparium with sternal spatula and head capsule of the enclosed final instar larva visible at left. [Scale line = 1 mm.] 8. Sternal spatula of final instar larva. [Scale line = 0.1 mm.] 9. Pupal exuvium of head showing long cephalic setae. [Scale line = 0.1 mm.] 10. Pupal prothoracic spiracle. [Scale line = 0.05 mm.]

Biology. On the only occasion that *Acumyia acericola* adults have been successfully reared, final instars remained alive and active within puparia for up to twenty months before pupating. Seventeen adults reared from larvae collected in summer, 2006, emerged in late April and early May 2008, with peak emergence on 04-06 May. This suggests that normal development of the species, which is almost certainly univoltine, is biennial. This length of development may result from the need for the hard woody covering of the *Acer* fruits to decay sufficiently to facilitate the emergence of adults from the enclosed fruit, which persist in leaf litter and the soil, and it may also be an adaptation to biennial fruiting of the host plants, but further observations will be needed to confirm these suggestions. Adult emergence in 2008 coincided with the development of soft young fruits on *Acer campestre* and the females presumably use their aciculate ovipositors to insert eggs into the ovular cavity. One fruit with an oviposition puncture was found at Sheepleas in May 2008 and dissection revealed a cluster of insect eggs within the cavity but follow-up observations failed to confirm the association with *Acumyia*, possibly because the infestation level was very low at that time (less than 1% fruits infested). Up to seven puparia have been found in single *Acer* fruits, mostly adjacent to the developing ovule, on which they presumably feed. Damaged ovules have a characteristic lumpy appearance in late summer.

Comments. This species occurs in continental Europe and plant quarantine interceptions in the USA indicate that it is also present in Japan, but I have not seen specimens. Dr R J Gagné (personal communication, August, 2008) has informed me that voucher specimens of larvae and puparia of this or another species intercepted at USA ports of entry are present in the National Museum of Natural History, Washington, DC (USNM). These specimens were collected on five separate occasions between 1966 and 1991 from *Acer palmatum, A. japonicum* and *A. polymorphum* imported from Japan, and there are additional specimens from *A. platanoides*, imported from Russia in 1981 and on *A. forestii* imported from China in 1994. In this last case the blade of the larval sternal spatula is two-toothed, which suggests that another species may be involved. Two puparia of *Acumyia* have been found recently in *Acer palmatum* seeds collected in Aomori Prefecture, Honshu, in northern Japan (Prof. Junichi Yukawa, personal communication, September, 2008).

Acknowledgements

This research began when puparia of *Acumyia acericola* were found by Dr Margaret Redfern while examining a sample of galled *Acer campestre* fruits collected in Hainault Forest, UK, by Brian Ecott in 2006. Subsequent investigation by the author has been greatly assisted by Dr Raymond J Gagné, Systematic Entomology Laboratory, USDA, Washington DC, USA; Dr Marcela Skuhravá, Prague, Czech Republic; Emeritus Professor Junichi Yukawa, Fukuoka-shi, Japan and Mr Peter Gosling, Forestry Commission Research Agency, Alice Holt Lodge, Farnham, UK.

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